

Mortality Factors of the Bent-winged Bat

By P. D. DWYER*

Introduction

This paper reports mortality factors of the bent-winged bat, *Miniopterus schreibersii* (Kuhl), observed during a three-year study of the species (April 1960-September 1963) in north-eastern New South Wales. In addition it attempts to assess the significance of these observations in terms of an estimated annual mortality in one population of the species. An understanding of the significant mortality factors for any species is important to possible understanding of number limitation in that species.

Several bat roosts present in the study area are mentioned below by name. Locality details for these are given on a map in Dwyer (MS in prep.). In summary, Camp Cave, Carrai, Moparrabah, Yessabah, and Willi Willi are limestone caves of the lower Macleay River Valley; Back Creek and Baker's Creek are mine tunnels of the Northern Tablelands; Euglah is a volcanic cave near the summit of Mt. Kaputar (Nandewar Range); Bonalbo is a mine tunnel of the upper Clarence River Valley; while Ashford, Riverton, and Viator are limestone caves of the Northwestern Slopes. Willi Willi and Riverton are breeding caves of *M. schreibersii*.

It should be noted that, although *M. schreibersii* is host to several ectoparasites (mites, ticks and flies), and endoparasites (trematodes, nematodes, etc.), there was no suggestion that these parasites contributed to mortality in the bat.

Results

Predation

Actual, or potential, predation on *M. schreibersii* by several reptiles, birds, and mammals, has been noted on a number of occasions. Not all instances occurred naturally and, in several, the specific identity of the predator was not determined.

Carpet snakes (*Morelia spilotes* (Lacépède)) have frequently been observed in the vicinity of roosts. In some cases the snakes have been found at the entrance to the roost (Carrai, Willi Willi, Riverton, and Bonalbo) and on one occasion, at Carrai, a snake was present well within the cave only a few inches from clustered bats. At Willi Willi a snake was observed at the cave entrance during the evening. It was hanging from a ledge in the middle of the flyway, where it would presumably have the greatest chance of capturing bats. Carpet snakes were not seen actually preying on bats but Mr. J. Frazier (pers. comm.) has observed a captive carpet snake picking flying *M. schreibersii* from the air in an aviary. He reported that the entire bat was consumed during feeding.

Grey butcher birds (*Cracticus torquatus* (Latham)) and black-backed magpies (*Gymnorhina tibicen* (Latham)) have been seen chasing bats when these have been released

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outside roosts during the day. On one occasion a large predatory bird, probably a goshawk (*Accipiter* sp.), caught a *M. schreibersii* just after this had been released. Boobook owls (*Ninox boobook* (Latham)) are widespread throughout the study area and have been heard calling in the immediate vicinity of many roosts. At Yassabah (November 1960) a boobook flew to a tree about 50 ft. from the cave entrance immediately after the first bat left the cave in the evening. This boobook was seen several times during the half-hour period of emergence. It was one of a pair that roosted on a limestone ledge, less than 100 yards from the cave entrance, throughout the study period. Only one, small, accumulation of pellets dropped by this pair was found and no bat remains were included. At Baker's Creek a boobook was present in a side tunnel of one of the mines on six of seven visits between June 1961 and April 1962. During this period 10 complete pellets, and fragments representing several others were collected. These included jaws of at least eight *M. schreibersii*, skulls of two *Chalinobus (morio)* (Gray)?, remains of at least seven *Rattus* sp., the skeleton of a small bird, a mandible of a small dasyurid, and numerous fragments of large coleopterous and orthopterous insects. It is clear that the *M. schreibersii* remains formed a considerable proportion of this deposit. Wing-bones of the bats were well represented in the pellets, so apparently wings were not discarded when the owl was feeding. Seven of the *M. schreibersii* were obtained in July 1961 when the pellets were first sampled. They were in rather fragmented pellets which were, therefore, probably relatively old. Presumably they were deposited in the previous autumn when bats were known to be quite numerous in the mine. The eighth *M. schreibersii* was

in a pellet deposited in early spring after bats had reappeared in the mine following a winter absence.

In summer 1962 a feral cat (*Felis catus* L.) was observed leaving Yessabah (Kempsey Speleological Society, pers. comm.). One banded bat was reported after it had been caught by a cat, and two bats were apparently taken by a cat during evening recording in a hut near Carrai. Domestic dogs have also captured and eaten *M. schreibersii*. In one case the bats were captured while flying within a cave (Angel, pers. comm.). Rats, possibly *R. assimilis* (Gould), have been observed at Carrai, Willi Willi, and Riverton, but predation has never been confirmed.

On July 8, 1961 an animal, apparently a mammal, was disturbed within Carrai at 9 p.m. Several thousand *M. schreibersii* were roosting within the cave and very few of these were flying. Three freshly-killed *M. schreibersii* were found on the floor about 50 ft. from the cave entrance near the place where the animal was first heard. These bats had blood on their heads and the throats of two had been slashed open. Troughton (1957) attributes weasel-like habits to several dasyurids (e.g. *Phascogale tapoatafa* (Meyer)) and it is possible that the disturbed animal was one of the larger dasyurids. Presumably the animal must have climbed the cave-wall to reach the bats.

Between March 1961 and September 1963, consistent predation on *M. schreibersii* by a fox (*Vulpes vulpes* L.) was followed at Yessabah (Dwyer, 1964a). Predation was evidenced by wing elements accumulating at particular sites within the cave. Remains of at least 476 *M. schreibersii* were collected during the period indicated above. The data obtained suggested that the fox visited the cave to prey upon *M. schreibersii* more frequently

when bat numbers were high. August and September visits in 1964 did not reveal any deposited wings and presumably bat predation by this fox had ceased before the previous autumn influx of juvenile bats.

A similar deposit of wing-bones to that observed at Yessabah was found a short distance inside Moparrabah in March 1961. At least 35 *M. schreibersii* were represented. The deposit was old and was present on a small rock-platform where the cross-section of the cave reduced to a space of about 4 x 3 ft.

Disease and infection

With the exception of a mass die-off of *M. schreibersii* recorded at Yessabah only one obviously infected individual was observed. This was a male captured at Back Creek on June 16, 1960 and had an infected growth or wound low on the back. Minor infections to the upper or lower forelimb have been noted several times.

The Yessabah die-off was first noticed on August 21, 1960, when 22 (21 female) recently dead *M. schreibersii* were found on the floor of the cave. A "large number" of dead bats was reported from Yessabah on October 29, 1960 (Carter, pers. comm.) and on November 13, 1960 139 *M. schreibersii* carcasses were found. These were in an advanced state of decomposition so that about half were little more than furred skeletons. Most of the bats were on their backs or bellies and had apparently died where they had landed after falling from the roofs. A few were hanging upside-down from low rocks or low on the cave walls. These had apparently crawled some distance after falling from the roof. It was not possible to recognise the sex of these dead bats or to determine the cause of death.

Reproductive deaths

Only one recorded death could be attributed to the stresses of parturition. The female was found on the wall of the Willi Willi breeding cave late in December. A considerable portion of the reproductive ducts and hind gut had been forced through the vulva during parturition.

A recently aborted foetus was found at Carrai on October 21, 1960. In one instance the condition of the pelvis and vulva of an adult female suggested that abortion had occurred. Death of a juvenile female born away from a maternity colony has been previously recorded (Dwyer 1963). Early death of juveniles born at maternity colonies would follow from death of the parent, and juvenile deaths are presumably also indicated by the capture of females, that have recently lactated, away from the maternity colonies before nursing duties should have ceased. One such female was taken at Viator on December 8, 1962.

Juvenile mortality at maternity colonies

Many juveniles die at the maternity colonies from early January onwards. At this time the oldest juveniles are becoming quite active on the roof and fall, or knock others to the ground (Dwyer, 1963). In January 1963 a small stream ran through the Willi Willi breeding cave, beneath the clustered young, and many of the falling young were immediately carried away from the colony. Even if these managed to escape drowning they would be unable to reach the clusters by climbing the walls. Consequently, mortality of juveniles at Willi Willi was probably increased by the presence of this stream. At Willi Willi several accumulations of juvenile *Miniopterus* skeletons were located on the guano, upstream from the clustered young. The

skulls of all of these had been bitten open. Rats were presumably responsible for these deposits, but whether they were actively preying upon juveniles, or were merely scavenging upon fallen and already doomed juveniles was not determined. It is clear, however, that bats are not the only source of food available to the rats, for these are present in the cave even in the months April to August when *M. schreibersii* are absent and relatively few other bats (i.e. *Rhinolophus megaphyllus* (Gray)) are present. At Riverton, mortality resulting from falling young may well be less than at Willi Willi for hazards such as streams, guano mounds, or rough walls, are less evident. Rats living at Riverton have been observed leaving the cave in the evening and presumably frequently feed outside. Certainly no accumulations of juvenile skeletons were found at Riverton.

In the period January 1-15 (1962-63) a sample of 365 bats taken away from the maternity colonies included 11 (3.0 per cent) adult females. By February 1-15, a sample of 367 included 48 (13.1 per cent) adult females. The increase in percentage of adult females presumably reflects mortality of juveniles at the maternity colonies over this interval. Most juveniles would be flying by mid-February and mortality from falling would decrease thereafter. The figures suggest that not less than 10 per cent of the juveniles die at the maternity colonies. It is considered unlikely that the percentage is much higher than this.

Deaths from unknown causes

From time to time dead bats are found and it is not possible to discover the cause of death. Skeletal material representing about 10 *M. schreibersii* was present on a rock ledge at Ashford and a complete skeleton was found on

the floor of a mine at Baker's Creek. Recently-dead bats were found on guano at Back Creek (August 1960, two individuals), Camp Cave (March 1961, one individual), and Euglah (May 1962, one juvenile). A dead banded bat was found on the wall of Carrai (July 1961) about six feet above floor level. There was a dense growth of fungus over the head and chest. In late March 1963 a dead female was found hanging from the cave wall at Ashford. The female had recently lactated and it is possible that death was related to the stresses of nursing.

Discussion

The Willi Willi breeding cave appears to serve a population of *M. schreibersii* occupying the drainage areas of the Macleay, Nambucca, and Bellinger Rivers (Dwyer, MS in prep.). This area is less than half the total study area. At Willi Willi more than 10,000 juveniles are born annually. For a numerically stable population the total annual mortality must equal the annual increment of juveniles. There was no suggestion during the study period that major changes were occurring in population size, and consequently, the number of *M. schreibersii* dying each year, in the Macleay region alone, must have been of the order of 10,000. It is striking, therefore, that with the exception of juveniles dying at the maternity colonies less than 700 deaths were accounted for in the entire study area during 41 months of investigation. Even including the estimate of 10 per cent for juvenile mortality at maternity colonies the discrepancy is great. The most generous estimate (doubling the estimate for juvenile mortality at maternity colonies and counting all other dead bats as being from the Macleay region) only accounts for 700 dead bats out of 40,000 deaths (i.e. in 3 years 5 months).

The remains of dead bats were only found at roosting sites. Other evidence for mortality, which was not based on discovering bat remains, also implied death at roosting sites. The most frequent causes of death for which evidence was obtained were due to predation or to juveniles falling from the roofs of breeding caves. It is unlikely that predation could be important except in the vicinity of roosts. This follows because bats would only be accessible to predators such as carpet snakes and mammals at entrances, or inside the roosts, and because it is unlikely that owls could be efficient predators of a high, and fast flying species such as *M. schreibersii*. Only one record of bats being preyed upon while roosting was obtained and, therefore, it is probable that predation would be greatest when large concentrations of bats were leaving or re-entering roosts. Records from more than 50 such flights suggest that, with respect to the total population size, predation is an incidental and not a major cause of death. The total number of juveniles dying at breeding caves is meagre compared with the total annual mortality. With the exception of these juveniles, and a single instance of a mass die-off, very few dead bats were found at roosting sites. It is possible, therefore, that most deaths of *M. schreibersii* occur away from the roosting sites and are due to mortality factors which have not been recognised.

It is suggested here that starvation might be a significant cause of death in *M. schreibersii*. In this bat a very high metabolic rate is maintained during flight while metabolic rate during roosting periods is much lower (Morrison 1959). Therefore, if insufficient food was found during a particular evening flight, death from starvation could occur. Such deaths would occur away from roosts. The

failure to lay down sufficient fat reserves before winter might lead to increased searching for food in unfavourable conditions (e.g., mid or late winter) and thus to starvation. It has been estimated that the mortality rate of bats in their first year is greater than that of older bats (Dwyer, MS in prep.). Since these juvenile individuals enter winter weighing less than older bats (Dwyer 1964b), their higher mortality rate might be explained in terms of an increased likelihood that they will attempt to feed during winter. In addition juveniles may be less efficient at selecting suitable wintering sites and, thereby, expend more energy either by transferring from roost to roost or by remaining longer in a metabolically less suitable roost. The autumn appearance of many juveniles at a wide range of sites contrasts conspicuously with the regular reformation of adult wintering colonies in this season (Dwyer, MS in prep.) and supports this last suggestion.

Finally, the details supplied for the recovery of one banded bat are consistent with the present suggestion that starvation could be a significant cause of death in *M. schreibersii*. The bat, an adult male, was recovered dead on July 5, 1964. It was found in the morning lying on the concrete floor of a dairy yard. It showed no evidence of having been molested by a potential predator and simply looked "as if it had died with the cold" (Mrs. R. Ford, pers. comm.).

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Book Review

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